

Wind Power Task Force Presentation  
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Having grown up in a farm family on my Mom's side, I always chuckle when I hear someone ask what is the best time to plant a tree. The answer of course is "20 years ago", but the second best time is today. To me this illustrates the immediacy of transforming our society away from one which utilizes fossil fuel for everything. Fossil fuels should be used sparingly for food production and pharmaceuticals. Our lifestyle, the lifestyle of North Americans specifically, is dependent upon cheap, inexpensive petroleum that will increasingly become more expensive and hard to extract in the next 20 or so years (Simmons, 2005). Back in the early 70's I was told that one day our descendants would ask 'What were the people of the 20<sup>th</sup> century thinking, when they burned petroleum for electricity, heat, and individual transportation'. I've always remembered my professor talking about Peak Oil and limits to growth, while my Dad – an oil company employee laughed at my gullibility. But now it is evident that the professor was correct and my dear Dad wrong, because the US is facing a double threat from related causes – Global Climate Change and Peak Oil (ref. King, 2006). Few people know about Peak Oil, and in the future I hope I can explain it, but right now I want to concentrate on what is at stake because of climate change.

Last August I was at Sugarloaf on the hottest day of the year and saw the presentation on the Redington Wind Farm. I had no idea what that power plant entailed. As a former employee of the Department of Environmental Services for the State of New Hampshire, I was used to reviewing transfer station, incineration and landfill permits. I have also helped to write applications for coal fired power plants in private industry and I work on nuclear power plants for the federal government. I looked at the material provided by the applicant. I was overwhelmed and not a little disgruntled at the size of the turbines. After the hearing I did some homework and soon discovered why the turbines proposed were so large. As an avid hiker and backpacker I did not want to see the turbines on pristine mountains. But looking at the terrain, I realized that this area had been hacked up by people hungry for timber; the roads and trails rutted by heavy logging trucks and ATVs, and realized this area is not pristine.

I believe in preserving the wolves outside Yellowstone, and spotted owls in old growth forests. I also want a strong economy, and to me there is no contradiction. If we don't have a healthy environment in which to live, the economy will collapse. As a Libra I look at all sides and weigh them. As a scientist, who does not believe in all that astrological nonsense, I believe in the scientific process of questioning, gathering data, forming hypotheses, testing them, formulating theories and adjusting those theories. Science is not static; it is dynamic always trying to find truth – even different truths.

My input into this process is that I would love to see a healthy Earth. I want clean water, clean air, limited human intrusion and basically a decrease in human impact and population to the point where humans can live harmoniously with the Earth's resources. I have an extensive science and technology background. The Sierra Club approach - take nothing but pictures, leave nothing but footprints reflects my feelings: but so does the Boy Scout motto "Be Prepared".

I taught geology – which includes the evolution of the Earth, life, the planets and the cosmos. In a more abstract plane there is Fermi's Dilemma – given the age of the universe, the unfathomable number of stars, some of them with Solar systems that can give rise to intelligent life, Fermi (the father of peaceful uses of nuclear energy) wondered where are all the Extra-terrestrials? I truly believe that other life is out there. But the only planet that I am 100% certain that has life is this planet. It's clear from the study of the universe and evolving planets that the early Earth was hostile to life as we know it. Microscopic organisms over billions of years left their impact on the hydrosphere and atmosphere creating an environment that allowed our world to evolve. This planet has had many massive extinctions, the most notable the extinction of the dinosaurs, - but contrary to popular opinion these extinctions were not caused by asteroid impacts. The mechanisms of extinctions are being studied, but carbon dioxide/methane/and oxygen relationships are implicated in most, if not all of them (Ward, 2007). Less flashy factors such as organisms fouling their habitats by changing the chemistry of the atmosphere, possibly combined with plate tectonics in turn affecting deep ocean currents and the ocean's oxygen supply have caused ecosystems to disappear throughout the geological record. When a lot of these ecosystems and individuals disappear at the same time, we call it an extinction.

Many scientists (Thomas, 2004) think we are in the middle of another great extinction, having lost saber toothed tigers, mammoths, mastodons, passenger pigeons, and dodo birds among numerous other, but less exotic fauna. Some of these animals would have gone extinct without man's influence, but many of them have been helped to extinction by human intervention. Morally, it's important to save animals like the northern bog lemming and Bicknell's thrush that Maine Audubon says are endangered by what is characterized as an "industrial power plant" on the top of fragile mountains. My feeling is that the planet is fragile. The hydrosphere of the whole planet has been impacted by organisms in the past and is being impacted by Human Beings right now. But we are the only species that has the knowledge and ability to realize it and change our ways. DDT, which we sprayed to kill mosquitoes bearing Yellow Fever and malaria, devastated bird populations, and when we realized what we were doing we stopped using it. However, the list of human induced unintended consequences is large. (I'll let the Audubon list them.) The deleterious effects of global warming are on an entirely different scale than earlier environmental "crises" we have faced. Global Climate change has taken longer to become recognized by the public and it has much greater consequences. We will have to sacrifice some places to save the majority of life on Earth, and it will take a long time and a lot of work, so we can't delay.

As a scientist I value dissent and discussion that prod scientists to prove their theses, revise them, and sometimes abandon them. However, the Media has been irresponsible in searching out the skeptic for the purpose of providing "a fair and balanced" perspective. The climate skeptics comprise a handful of people – a few scientists with an anomalous data point, others have agendas paid for and supported by powerful corporations run by businessmen looking profits, and a couple are merely seeking notoriety. The thousands of scientists that study climate change are debating the rapidness, the mechanisms and the effects of climate change, not the theory and not the immediate direction. The media has done a disservice to the public implying that the science is not decided.

The majority of climate change models are linear using an envelope with an upper bound, a lower bound and a mean based on the rates of carbon dioxide emissions (among

other parameters) and projecting the slopes into the future. The modelers without exception have emphasized that the projections are means, that the outliers will be exaggerated in both directions. That means that some winters will have more blizzards than now, and the hot spells will be hotter, but overall climate will be more energetic. I consider these models to be conservative, but they are what the IPCC reports. Feedback mechanisms are difficult to integrate into these models and the models under predict the variability inherent in natural systems. (Reference: Wake, personal communication; Shrag, personal communication; Rial et al., and personal experience)

One non-linear model has elegantly produced two very different modes – glacial and interglacials. (Ref: Rial, J. A, et al) This highly non-linear model with chaotic aspects models the past better than any I've seen, and can be projected forward as well. It shows how delicate the balance is within a glacial oscillation and how a tiny perturbation can cause rapid climate departures toward a tropical climate or a stagnant ocean. I believe this model is more predictive of the future climate on Earth, but it still does not exhibit the extremes of annual weather variations that we experience. But back to the linear models, which are simpler and easier to work with do include linear forcing. These models, show that as the polar ice caps melt, the albedo or reflectivity of the Earth changes, reflecting less of the Sun's rays and capturing more heat. As the Earth warms the permafrost melts, giving off methane, another potent greenhouse gas. Melting permafrost facilitates tundra and peat moss drying; creating a supply of dry carboniferous material that will burn, if hit by lightening. Subsequent fires will produce carbon dioxide accelerating climate change. Increasing rainfall in North America, and melting Greenland's Icecap will dump fresh water into the North Atlantic Ocean, which in turn could cause the massive deep ocean currents to stall (Broecker, 2004) starting a chain of events that could drastically alter the planet ecosystems to the point of initiating an extinction of 40% or more of the species on Earth (Harte, et al., 2004).

At the Equator as the temperature rises, plants, already at the extreme range of their niches, slow their growth taking up less carbon dioxide. (Monbiot, 2006). We cannot accurately predict the effects of Global Climate Change and that is where a lot of research is on-going and seemingly contradictory. The fact that the scientists agreed to state a minimum rate of sea level rise in the 4<sup>th</sup> IPCC report is amazing. It's hard to comprehend how those who project a 20 foot sea level rise in this century could agree to the conservative projections in the IPCC report. It's clear that the IPCC report has been vetted by economists or government functionaries and forced to conform to less controversial, more same old same old slow climate change that they hope for and aren't alarmed by, so that they can plan and let economic forces have time to work. But, Mother Nature did not attend that conference! In a similar way Peak Oil signals are even now being obscured by politicians and oil companies alike, as future oil and petroleum production is grossly over-exaggerated by wishful thinking. (ASPO newsletter, July 18, 2007)

The scientists I know feel it is fool hardy to think we are going to do business as usual and stay on the projected lower boundary of the climate change envelope. We need to work individually and jointly on combating global warming and oil depletion by changing our habits and our society. Many economists with an understanding of carbon emissions and climate change do not believe that free market forces can contend with the insidious nature of climate change. The effects of carbon dioxide and other gases upon the atmosphere were known in 1896, but until recently few have studied or acknowledged the possibility of

anthropomorphic climate change. It took 150 to 200 years after the initial industrial carbon input to recognize the climate change signal. Economic signals may lead humans to change things quickly, but they are lagging the environmental signals by at least 70 years. The economic signals portending Peak Oil are being obscured by oil companies, OPEC and geopolitics. Undoing the climate damage will take at least a century, but we will never be able to reconstitute all the petroleum that we have blithely burned.

Global Climate change, the magnitude, and the time scale are difficult for people to understand. Impacts on local and regional scales are what most of us see and feel, and having a huge wind turbine on a beautiful ridge top is hard to accept. We can hike up and see that turbine, but we can't take a hike and see carbon dioxide levels rising or the deep ocean currents slowing, or oil depleting. So understandably we won't want to implement changes in our behavior or surroundings until we are really suffering. (Ref. Randers, 2007)

I don't have the answer to where wind farms should be placed, but given the consequences of climate change, even based on conservative models, few places should be ruled out. (Ref: Charles Komanoff's "Whither Wind" from Orion Magazine) Along with massive individual and governmental conservation efforts, I feel we need to utilize places that have the strongest winds; the places with the most sustained winds, and the places closest to infrastructure. With climate change - wind speed and possibly direction will be modified (Schwartz and Randall, 2003), so we ought to be putting turbines in places that are most economic to develop.

We all know of problems with wind turbines that happened at specific sites, with specific designs of support towers, with specific times of the year and locations that have caused bird and bat kills. Characterizing a wind turbine as a slice and dice machine for killing birds and bats is inappropriate for correctly developed and operated wind farms. Opponents of modern wind farms use specious arguments that tug at heart strings, and work on people's lack of knowledge or misinformation or out-dated information and fears. Humans will have to evolve and accept change or perish taking the majority of life on the planet with us.

We should have planned our energy policy 34 years ago, learning from our first oil crisis in 1973 predicted by M. King Hubbard in 1950 based on his Peak Oil theory of the US oil field depletion. Let's not delay anymore. The longer we postpone changing our ways the more drastic will be the solutions imposed upon our descendants by Nature. We are experiencing changes already in spring floods and the growing seasons (Wake et al). We have to make tradeoffs between what we want and what we need. We need to facilitate the process, because the living Earth and its creatures can't wait.

What I am trying to say is that my perspective is long-range – 150 to 300 years or longer. I don't look at the economic bottom line every quarter or even every year. I look at long term, small scale, global impact changes, and even though a single turbine will not make much difference, I look at that turbine like I look at a grain of sand on a beach. Each sand grain adds to the beach, each turbine aids in combating carbon dioxide emissions on Earth and decreases our dependence on dwindling non-renewable fossil fuels.

Thank you for the opportunity to work on the Task Force as a panelist and provide information on aspects of earth and planetary sciences with which you might not be familiar.

